FORM PTO 1390 (REV. 12-29-99) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER: DHN/321/PC/US

U.S. APPLICATION NO. (If known, see 37 CFR 1.5): 10/018768

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/EP00/05831	June 23, 2000	June 23, 1999

TITLE OF INVENTION: Inhalers

APPLICANT(S) FOR DO/EO/US: Quentin J. Harmer, et al

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☒ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US)
6. ☐ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☐ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or Declaration of the Inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 16 below concern document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An Assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A FIRST Preliminary Amendment.
    A SECOND or SUBSEQUENT Preliminary Amendment.
14. ☒ A substitute specification.
15. ☐ A change of Power of Attorney and/or address letter.
16. ☒ Other items or information:

Copy of IPER

EXPRESS MAIL mailing label number EL895170579US

I, Talisha L. Cooper, hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" Service under 37 CFR 1.10 on December 17, 2001 and is addressed to "Box PCT, Commissioner for Patents, United States Patent and Trademark Office, P.O. Box 2327, Arlington, Virginia 22202."

Talisha L. Cooper

U.S. APPLICATION NO. (if known, see 37CFR 1.5)	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
10/018768	PCT/EP00/05831	DHN/321/PC/US

	CALCULATIONS	PTO USE ONLY
17. ☒ The following fees are submitted:		
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)):		
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37CFR 1.445 (a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO $		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO . . . . . $		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO . . . . . $		
International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33 (1) – (4) . . . . . $		
International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims satisfied provisions of PCT Article 33 (1) – (4) . . . . . $		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 890.00	
Surcharge of $130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$ 0	

CLAIMS	NUMER FILED	NUMBER EXTRA	RATE		
Total claims	20 - 20 =		X $	$ 0	
Independent claims	3 - 3 =		X $	$ 0	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ $	$ 0	
TOTAL OF ABOVE CALCULATIONS =				$	
Reduction of ½ for filing by small entity, if applicable. A Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28).				$	
SUBTOTAL =				$ 890.00	
Surcharge of $130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)) +				$	
TOTAL NATIONAL FEE =				$ 890.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). $40.00 per property. +				$	
TOTAL FEES ENCLOSED =				$ 890.00	
				Amount to be refunded:	$
				Charged:	$

a. ☒ A check in the amount of $ 890.00 to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account Number 16-2563 in the amount of $_____ to cover the above fees. *A duplicate copy of this sheet is enclosed.*

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 16-2563 *A duplicate copy of this sheet is enclosed.*

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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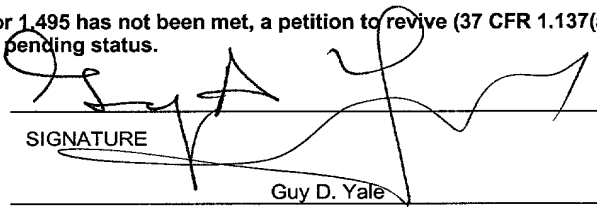

SIGNATURE

Guy D. Yale

NAME

29,125

REGISTRATION NUMBER

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of Quentin J. Harmer, et al

Application No. Examiner:

Filing Date: Group Art Unit:

International Application No.: PCT/EP00/05831

International Filing Date: June 23, 2000

For: Inhalers

Commissioner for Patents
United States Patent and Trademark Office
P.O. Box 2327
Arlington, Virginia 22202

Sir:

PRELIMINARY AMENDMENT

Before calculating the filing fee and examining the above-identified application, please enter the following amendments. The amendments should be made with respect to the international application published under the Patent Cooperation Treaty as International Publication No. WO 0100262 A1 on January 4, 2001 (as originally filed).

In the Abstract:

Please rewrite the Abstract as the Abstract of the Disclosure on the attached sheet.

In the Specification:

After the title, insert: **—CROSS-REFERENCE TO RELATED APPLICATION**

This application is the U.S. National Phase application of International Application No. PCT/EP00/05831 filed June 23, 2000.

BACKGROUND OF THE INVENTION—

Page 3, after line 18, insert —**SUMMARY OF THE INVENTION—**

Page 6, after line 22, insert —**BRIEF DESCRIPTION OF THE DRAWINGS—**

Page 6, after line 33, insert —**DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS—**

In the claims:

Please amend claims 3, 5 and 6 as follows:

3. (amended) An inhaler as claimed in claim 1 [or 2], wherein the cyclone is in the form of a cylinder of a diameter between about 2 and 15 mm.

5. (amended) An inhaler as claimed in [any of preceding] claim 1, wherein the chamber is comparable in volume to the cyclone.

6. (amended) An inhaler as claimed in [any of claims] claim 1 [to 4], wherein the chamber has a volume of around 300 ml.

Please add new claims 11 through 20 as follows:

11. An inhaler as claimed in claim 2, wherein the cyclone is in the form of a cylinder of a diameter between about 2 and 15 mm.

12. An inhaler as claimed in claim 2, wherein the chamber is comparable in volume to the cyclone.

13. An inhaler as claimed in claim 3, wherein the chamber is comparable in volume to the cyclone.

14. An inhaler as claimed in claim 4, wherein the chamber is comparable in volume to the cyclone.

15. An inhaler as claimed in claim 2, wherein the chamber has a volume of around 300 ml.

16. An inhaler as claimed in claim 3, wherein the chamber has a volume of around 300 ml.

17. An inhaler as claimed in claim 4, wherein the chamber has a volume of around 300 ml.

18. An inhaler as claimed in claim 5, wherein the chamber has a volume of around 300 ml.

19. An inhaler as claimed in claim 11, wherein the chamber has a volume of around 300 ml.

20. An inhaler as claimed in claim 12, wherein the chamber has a volume of around 300 ml.

A substitute specification incorporating a clean copy of the amendments is submitted herewith.

REMARKS

Applicant has amended the PCT application to conform same to U.S. patent practice and to eliminate multiple dependent claims.

Upon entry of the amendment, claims 1 to 20 will be pending for consideration.

Applicant requests that the amendments be made prior to calculation of the filing fee and examination of the application.

The application to be examined is the substitute specification submitted herewith.

Respectfully Submitted,

Quentin J. Harmer, et al

By: _____
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ABSTRACT OF THE DISCLOSURE

An inhaler comprises a pump 17, a drug dosing device 15 and a cyclone 1 which delivers an aerosol of powdered medicament from the drug dosing device 15 into a chamber 11 when the pump 17 is activated. The aerosol is inhaled by the user through a mouthpiece 13.

PCT/EP00/05831

Inhalers

The present invention relates to inhalers and in particular inhalers for the delivery of a medicament to the lung, more particularly a medicament in powder form.

In recent times, there has been a growing interest in the systemic delivery of pharmaceutically-active medicaments via the lung. Such a method of delivery is generally more attractive to the patient than methods such as injection, because it does not involve a needle and can be carried out discreetly in public.

In the case of medicaments in liquid form, the provision of an inhalable aerosol of the medicament can be achieved with a nebuliser or the like. A known device for generating a turbulent airflow in a nebuliser is a so-called "cyclone". The cyclone comprises a cylindrical chamber with an axial outlet and a tangential inlet.

However, for a medicament in solid form, such as crystals, the provision of an inhalable aerosol is more difficult, because it is necessary to achieve a large repeatable dose of fine particles. In order for the particles of medicament to reach the lung and thus be absorbed into the bloodstream, the particles must have an effective diameter approximately in the range 3-5 μm. If the particles are larger than 5 μm they may not be transported by the inhaled airflow deep into the lung, because they are likely to be trapped in the respiratory passages before reaching the deep lung. For example, particles of the order of 10 μm are unlikely to progress further than the trachea and particles of the order of 50 μm tend to deposit on the back of the throat when inhaled. Furthermore, if the particles are less than 1 μm in effective diameter, the particles may not be absorbed in the lung, because they are small enough to be expelled from the lung with the exhaled airflow.

Thus, it will be seen that it is important that the powdered medicament is delivered with an accurately controlled range of particle size in order that it is absorbed effectively in the lung.

It is known for the powdered medicament to be mixed with an excipient (an inert substance, such as lactose, which is combined with the medicament to prepare a convenient dosage form) of relatively large particle size, for example 50-100 μm, to improve the handling properties of the medicament. The medicament attaches electrostatically to the surface of the excipient. In some cases, the particles of medicament agglomerate to form particles of a larger effective diameter. In either case, it is necessary to separate the medicament particles from the excipient and from each other in order to provide an inhalable aerosol which will deliver the medicament for absorption through the lung.

In order to separate the particles, shear forces must be generated between the particles, for example by providing a substantial velocity gradient across the particles. This may be done, for example, by forcing the powder through a narrow nozzle at high speed or introducing the powder into a turbulent air stream.

In traditional metered dose inhalers (MDIs) it is common for the emitted dose (the amount of medicament that enters the patient's airway) to be around 80-90% of the dose ejected from the inhaler. The respirable dose (the amount of medicament that reaches the lung) may be only around 50% of the emitted dose. However, the variation in the respirable dose of known inhalers can be ± 20-30%. Such variation may be acceptable in the case of asthma drugs and the like, but when the medicament is a more potent drug such as insulin, growth hormone or morphine, this amount of variability in the dosing is unacceptable. The relatively low respirable dose also represents a significant wastage of what may be an expensive drug. Furthermore, there may be side

effects if the proportion of the emitted dose which is not respired is swallowed.

Thus, it is important for the systemic delivery of medicaments by inhalation that a repeatable dose of fine particles can be produced.

It is known for so-called "spacers" to be used in the generation of the aerosol from a metered dose inhaler. The spacer fits onto the mouthpiece of the inhaler and comprises a chamber into which the dose of medicament is ejected by the inhaler. The patient is then able to inhale the dose from the spacer through a corresponding mouthpiece on the spacer.

Large volume spacers are used where the patient is unable to inhale at the same time as operating the metered dose inhaler due to a lack of coordination. Small volume spacers are used to trap large particles which would stick to the back of the throat and may cause undesirable side-effects.

The present invention, at least in its preferred embodiments, seeks to provide an inhaler for generating an inhalable aerosol of a powdered medicament with an effective particle size that is sufficiently small for the medicament to be delivered to and absorbed in the lungs of a patient.

Thus, viewed from a first aspect the invention provides an inhaler comprising:

a chamber having a mouthpiece;

a cyclone arranged to eject an aerosol of medicament into the chamber; and

a drug dosing device arranged to provide a dose of powdered medicament entrained in an airflow to the cyclone.

In use of the inhaler, the powdered medicament is entrained in an airflow by the drug dosing device and expelled through the cyclone into the chamber as an aerosol for subsequent inhalation by a patient.

Thus, the invention provides a simple arrangement

which can generate an inhalable, fine-particle dose of a dry powder medicament.

In general, the cyclone is configured as a substantially cylindrical cavity provided with a tangential inlet and an axial outlet. The cyclone may be provided with a frustoconical portion in the region of the outlet for directing the airflow within the cyclone towards the outlet.

In one arrangement, the cyclone is provided with a further axial inlet. The further axial inlet is arranged to introduce the medicament close to the axis of the cyclone to reduce deposition of the medicament on the internal surfaces of the cyclone.

It is desirable for the cyclone to generate as much shear as possible within the airflow. At small radii, close to the axis of the cyclone, the high angular velocities increase the effective viscosity of the air causing a central cylindrical region lying along the axis to rotate as a rigid body within which the shear forces are minimal. Thus, according to an advantageous arrangement, the cyclone is provided with an axial member for directing the medicament towards the walls of the cyclone. In this way, the aerosol is unable to enter the very central zone of the cyclone where the shear forces are at a minimum. Alternatively or in addition, the outlet of the cyclone may be annular to encourage the airflow away from the central axial region of the cyclone.

It is also desirable to reduce the amount of deposition in the chamber of the inhaler and to allow a smaller chamber to be used. Thus, a diffuser may be provided at the outlet of the cyclone. The diffuser may comprise an axial and/or an annular diffuser with a gradual increase in cross-sectional area, preferably with an exponential increase in area for improved diffusion.

A small chamber may be provided at the outlet of

the cyclone comparable in volume to the cyclone itself to act as a diffuser. Similarly, a spacer may be provided at the outlet of the cyclone to act as a diffuser.

A plurality of cyclones may be provided such that their outlet flows coincide and interfere with each other to create extra shear forces.

The airflow to the drug dosing device may be provided by an external air source, for example a source of compressed air. In a preferred arrangement, however, the airflow is provided by a pump in the inhaler. Thus, the inhaler may comprise a pump. The pump may be in the form of, for example, a piston pump, a resilient bladder or a source of compressed gas, such as a gas canister. Preferably, the pump is arranged to provide an airflow of repeatable volume and velocity. Thus, the pump may take the form of a spring-powered piston received in a cylinder.

It has been identified that a problem associated with inhalers of the type according to the invention is that when the aerosol is expelled into the chamber, the aerosol tends to interact unfavourably with the air in the chamber. It is known for the chamber to be open and for the air initially within the chamber to be expelled through the mouthpiece of the chamber as the aerosol is introduced through a nozzle. However, this has been found to be unsatisfactory as the amount of medicament which escapes through the mouthpiece before the user inhales is unquantifiable.

Thus, viewed from a further aspect, the invention provides an inhaler comprising:

a chamber having a mouthpiece; and

an aerosolising device having an inlet for taking in an airflow and an outlet for expelling an aerosol into the chamber, wherein the inlet of the aerosolising device is connected to the chamber, such that, in use, the airflow is drawn from the chamber to generate the

aerosol.

Thus, according to this aspect of the invention air from within the chamber passes through the aerosolising device to generate the aerosol so that the chamber can be filled with aerosol without expelling air, and potentially medicament, through the mouthpiece of the chamber.

The aerosolising device may comprise a cyclone and/or a drug dosing device as previously described. The aerosolising device may also comprise a pump arranged to draw air from the chamber via the inlet.

In one arrangement, the chamber receives a plunger which is arranged to force air through the aerosolising device as the plunger moves through the chamber. In a particularly preferred embodiment, the aerosolising device is mounted on the plunger.

Thus viewed from a yet further aspect the invention provides an inhaler comprising a chamber having a mouthpiece and a plunger received in the chamber, wherein the plunger is arranged to force air through an aerosolising device to generate an aerosol of medicament in the chamber for inhalation through the mouthpiece.

Some embodiments of the invention will now be described by way of example only and with reference to the accompanying drawings, in which:

Figure 1 shows a cyclone for use in the invention;

Figure 2 shows a first embodiment of the invention;

Figure 3 shows a second embodiment of the invention;

Figure 4 shows a third embodiment of the invention;

Figure 5 shows a fourth embodiment of the invention; and

Figure 6 shows a fifth embodiment of the invention.

Corresponding reference numerals have been used for corresponding parts in each embodiment of the invention.

Figure 1 shows a cyclone 1 for use in aerosolising a powdered medicament according to the invention. The

cyclone 1 is in the form of a cylinder 3 of a diameter between about 2 and 15 mm, preferably between 4 and 10 mm. The cylinder 3 is closed at an input end and provided with a frustoconical portion 5 at an output end. The cyclone 1 has an inlet 9 in the region of the closed input end of the cylinder 3, which input 9 is substantially tangential to the wall of the cylinder 3. The frustoconical portion 5 has an outlet 7 defined therein, which outlet 7 is concentric with the axis of the cylinder 3.

In use, an airflow entrains a powdered medicament and enters the cyclone 1 through the tangential inlet 9, as indicated by arrows A. The airflow (and medicament) is directed by the internal surface of the cylinder 3 in a helical path towards the outlet 7. The frustoconical portion 5 of the cyclone 1 narrows the radius of the helical path, thereby increasing the speed of the airflow and increasing the shear forces on the entrained medicament. Consequently, an aerosol of powdered medicament having particles of respirable size issues from the outlet 7 of the cyclone 1, as indicated by arrows B.

Figure 2 shows a first embodiment of the invention. According to this embodiment a cyclone 1 is connected to a chamber 11 having a mouthpiece 13. The chamber has a volume of around 300 ml. The cyclone 1 is located at an end of the chamber 11 opposite the mouthpiece 13, and the outlet 7 of the cyclone 1 is arranged to eject the aerosol of medicament into the chamber 11 towards the mouthpiece 13, as indicated by arrows B.

A drug dosing device 15 is connected to the inlet 9 of the cyclone 1 and is arranged such that, as a flow of air passes through the dosing device 15, a controlled dose of medicament is entrained in the airflow.

The airflow to the drug dosing device 15 is provided by a pump 17, which comprises a plunger 19 received in a pump cylinder 21 and biased towards an

outlet 23 of the pump 17 by a spring 25. A breath-actuated mechanism (not shown) is used to retain the plunger 19 in a retracted position against the biasing force of the spring 25 until the medicament is to be delivered.

In use, this embodiment of the invention operates as follows. The user primes the inhaler by pulling the plunger 19 of the pump 17 into the retracted position where it is retained by the breath-actuated mechanism. The user then inhales through the mouthpiece 13 of the chamber 11 and the resultant drop in pressure causes the breath-actuated mechanism to release the plunger 19 which forces a jet of air through the outlet 23 and the drug dosing device 15. The flow of air entrains a measured dose of medicament from the dosing device 15 and carries this dose into the cyclone 1. In the cyclone 1, the dose of medicament is aerosolised, as described in relation to Figure 1, and is expelled into the chamber 11 through the outlet 7, as indicated by the arrows B. The user is then able to inhale the aerosol of medicament into the deep lung via the mouthpiece 13.

Figure 3 shows a second embodiment of the invention. In this embodiment, the arrangement of the pump 17, dosing device 15 and cyclone 1 corresponds substantially to that of the embodiment of Figure 2. However, in this case the chamber 11 is larger than that shown in Figure 2 and the mouthpiece 13 is offset from the axis of the chamber 11 and of the cyclone 1. The mouthpiece 13 is provided with a cap 27 which closes off the mouthpiece, sealing the chamber 11 from the atmosphere. The cap 27 also closes off an air intake passage 29 which is provided in the chamber 11 to allow air to enter the chamber 11 when the user inhales through the mouthpiece 13. The chamber 11 connects to the outlet 23 of the pump 17 via an air passage 31 and a first non-return valve 33. A second non-return valve 35 is provided between the outlet 23 of the pump 17 and the

drug dosing device 15.

In operation of this embodiment, the plunger 19 of the pump 17 is withdrawn (as in the embodiment of Figure 2) which causes air to be drawn out of the chamber 11 through the air passage 31 and into the pump cylinder 21 via the first non-return valve 33. In this manner, the pressure in the chamber 11 is reduced to below atmospheric. It is to be noted that the release of the plunger 19 in this embodiment is not effected by a breath-actuated device but by a manually actuated release mechanism (not shown). When the release mechanism is actuated, the plunger 19 forces a jet of air through the second non-return valve 35 into the drug dosing device 15 where a measured dose of the medicament is entrained in the air stream. The airflow and entrained medicament pass into the cyclone 1 where the medicament is aerosolised and expelled from the outlet 7 of the cyclone 1 into the chamber 11, as indicated by the arrows B. The reduced pressure in the chamber 11 at this point ensures an even distribution of the aerosol within the chamber 11. The pressure is equalised by the ejection of the aerosol into the chamber 11. Once the aerosol has been delivered into the chamber 11, the user removes the cap 27 and inhales the aerosol through the mouthpiece 13.

Figure 4 shows a third embodiment of the invention. According to this embodiment, there is no pump 17, but a plunger 19 is provided within the chamber 11 so that the chamber itself acts as a pump cylinder. Thus, as the plunger 19 is driven in the direction of the arrow C, air is forced out of the chamber 11 through the air passage 31 and into the drug dosing device 15. As the air passes through the drug dosing device 15 it entrains a measured dose of medicament which passes into the cyclone 1 and is aerosolised and expelled into the chamber 11, as indicated by the arrows B. The user inhales the aerosol of medicament by removing the cap 27

and inhaling through the mouthpiece 13.

Figure 5 shows a fourth embodiment of the invention according to which the cyclone 1, the drug dosing device 15 and the air passage 31 are mounted on the plunger 19 and are movable therewith such that when the plunger 19 is moved in the direction of the arrow C, air from the lower half of the chamber 11 passes into the air passage 31 and through the drug dosing device 15, so that an aerosol of medicament is expelled from the cyclone 1 into the upper half of the chamber 11, in the direction of the arrows B.

Figure 6 shows a fifth embodiment of the invention which corresponds substantially to that of Figure 4 except that the cyclone 1 in this embodiment is located in a lower region of the chamber 11 and the direction of movement of the plunger 19 to generate the aerosol is reversed, as indicated by arrow C.

The embodiments of Figures 3 to 6 each have the particular advantage that the airflow which is used to entrain the medicament and generate the aerosol via the cyclone 1 is drawn from the chamber 11. Thus, a substantially equal volume of air is withdrawn from the chamber 11 to generate the aerosol as is returned to the chamber 11 when the aerosol is expelled from the cyclone 1. In this way, there is no requirement for the chamber 11 to be vented to atmosphere while the aerosol is generated and there is therefore no risk that any of the medicament will be lost before inhalation by the user.

Although there have been described herein a number of discrete embodiments, the features described in relation to any particular embodiment may be used in combination with the features of other embodiments described herein.

Although the aerosol of medicament has been described herein as an aerosol of powdered medicament in air, the medicament may be dispersed in any other gas or mixture of gases, as required.

Claims

1. An inhaler comprising:

a chamber having a mouthpiece;

a cyclone arranged to eject an aerosol of medicament into the chamber; and

a drug dosing device arranged to provide a dose of powdered medicament to the cyclone.

2. An inhaler as claimed in claim 1, wherein the drug dosing device is arranged to provide a dose of powdered medicament entrained in an airflow to the cyclone.

3. An inhaler as claimed in claim 1 or 2, wherein the cyclone is in the form of a cylinder of a diameter between about 2 and 15 mm.

4. An inhaler as claimed in claim 3, wherein the diameter of the cylinder is between 4 and 10 mm.

5. An inhaler as claimed in any preceding claim, wherein the chamber is comparable in volume to the cyclone.

6. An inhaler as claimed in any of claims 1 to 4, wherein the chamber has a volume of around 300 ml.

7. An inhaler comprising:

a chamber having a mouthpiece; and

an aerosolising device having an inlet for taking in an airflow and an outlet for expelling an aerosol into the chamber,

wherein the inlet of the aerosolising device is connected to the chamber, such that, in use, the airflow is drawn from the chamber to generate the aerosol.

8. An inhaler as claimed in claim 7, wherein the

chamber receives a plunger which is arranged to force air through the aerosolising device as the plunger moves through the chamber.

9. An inhaler as claimed in claim 8, wherein the aerosolising device is mounted on the plunger.

10. An inhaler comprising a chamber having a mouthpiece and a plunger received in the chamber, wherein the plunger is arranged to force air through an aerosolising device to generate an aerosol of medicament in the chamber for inhalation through the mouthpiece.

INHALERS

CROSS-REFERENCE TO RELATED APPLICATION

This application is the U.S. National Phase application of International Application No. PCT/EP00/05831 filed June 23, 2000.

BACKGROUND OF THE INVENTION

The present invention relates to inhalers and in particular inhalers for the delivery of a medicament to the lung, more particularly a medicament in powder form.

In recent times, there has been a growing interest in the systemic delivery of pharmaceutically-active medicaments via the lung. Such a method of delivery is generally more attractive to the patient than methods such as injection, because it does not involve a needle and can be carried out discreetly in public.

In the case of medicaments in liquid form, the provision of an inhalable aerosol of the medicament can be achieved with a nebulizer or the like. A known device for generating a turbulent airflow in a nebulizer is a so-called "cyclone". The cyclone comprises a cylindrical chamber with an axial outlet and a tangential inlet.

However, for a medicament in solid form, such as crystals, the provision of an inhalable aerosol is more difficult, because it is necessary to achieve a large repeatable dose of fine particles. In order for the particles of medicament to reach the lung and thus be absorbed into the bloodstream, the particles must have an effective diameter approximately in the range 3-5 μm. If the particles are larger than 5 μm they may not be transported by the inhaled airflow deep into the lung, because they are likely to be trapped in the respiratory passages before reaching the deep lung. For example, particles of the order of 10 μm are unlikely to progress further than the trachea and particles of the order of 50 μm tend to deposit on the back of the throat when inhaled. Furthermore, if the particles are less than 1 μm in effective diameter, the particles may not be absorbed in the lung, because they are small enough to be expelled from the lung with the exhaled airflow.

Thus, it will be seen that it is important that the powdered medicament is delivered with an accurately controlled range of particle size in order that it is absorbed effectively in the lung.

It is known for the powdered medicament to be mixed with an excipient (an inert substance, such as lactose, which is combined with the medicament to prepare a convenient dosage form) of relatively large particle size, for example 50-100 μm, to improve the handling properties of the medicament. The medicament attaches electrostatically to the surface of the excipient. In some cases, the particles of medicament agglomerate to form particles of a larger effective diameter. In either case, it is necessary to separate the medicament particles from the excipient and from each other in order to provide an inhalable aerosol which will deliver the medicament for absorption through the lung.

In order to separate the particles, shear forces must be generated between the particles, for example by providing a substantial velocity gradient across the particles. This may be done, for example, by forcing the powder through a narrow nozzle at high speed or introducing the powder into a turbulent air stream.

In traditional metered dose inhalers (MDIs) it is common for the emitted dose (the amount of medicament that enters the patient's airway) to be around 80-90% of the dose ejected from the inhaler. The respirable dose (the amount of medicament that reaches the lung) may be only around 50% of the emitted dose. However, the variation in the respirable dose of known inhalers can be ± 20-30%. Such variation may be acceptable in the case of asthma drugs and the like, but when the medicament is a more potent drug such as insulin, growth hormone or morphine, this amount of variability in the dosing is unacceptable. The relatively low respirable dose also represents a significant wastage of what may be an expensive drug. Furthermore, there may be side effects if the proportion of the emitted dose which is not respired is swallowed.

Thus, it is important for the systemic delivery of medicaments by inhalation that a repeatable dose of fine particles can be produced.

It is known for so-called "spacers" to be used in the generation of the aerosol from a metered dose inhaler. The spacer fits onto the mouthpiece of the inhaler and comprises a chamber into which the dose of medicament is

ejected by the inhaler. The patient is then able to inhale the dose from the spacer through a corresponding mouthpiece on the spacer.

Large volume spacers are used where the patient is unable to inhale at the same time as operating the metered dose inhaler due to a lack of coordination. Small volume spacers are used to trap large particles which would stick to the back of the throat and may cause undesirable side-effects.

SUMMARY OF THE INVENTION

The present invention, at least in its preferred embodiments, seeks to provide an inhaler for generating an inhalable aerosol of a powdered medicament with an effective particle size that is sufficiently small for the medicament to be delivered to and absorbed in the lungs of a patient.

Thus, viewed from a first aspect the invention provides an inhaler comprising:

a chamber having a mouthpiece;

a cyclone arranged to eject an aerosol of medicament into the chamber; and

a drug dosing device arranged to provide a dose of powdered medicament entrained in an airflow to the cyclone.

In use of the inhaler, the powdered medicament is entrained in an airflow by the drug dosing device and expelled through the cyclone into the chamber as an aerosol for subsequent inhalation by a patient.

Thus, the invention provides a simple arrangement which can generate an inhalable, fine-particle dose of a dry powder medicament.

In general, the cyclone is configured as a substantially cylindrical cavity provided with a tangential inlet and an axial outlet. The cyclone may be provided with a frustoconical portion in the region of the outlet for directing the airflow within the cyclone towards the outlet.

In one arrangement, the cyclone is provided with a further axial inlet. The further axial inlet is arranged to introduce the medicament close to the axis of the cyclone to reduce deposition of the medicament on the internal surfaces of the cyclone.

It is desirable for the cyclone to generate as much shear as possible within the airflow. At small radii, close to the axis of the cyclone, the high

angular velocities increase the effective viscosity of the air causing a central cylindrical region lying along the axis to rotate as a rigid body within which the shear forces are minimal. Thus, according to an advantageous arrangement, the cyclone is provided with an axial member for directing the medicament towards the walls of the cyclone. In this way, the aerosol is unable to enter the very central zone of the cyclone where the shear forces are at a minimum. Alternatively or in addition, the outlet of the cyclone may be annular to encourage the airflow away from the central axial region of the cyclone.

It is also desirable to reduce the amount of deposition in the chamber of the inhaler and to allow a smaller chamber to be used. Thus, a diffuser may be provided at the outlet of the cyclone. The diffuser may comprise an axial and/or an annular diffuser with a gradual increase in cross-sectional area, preferably with an exponential increase in area for improved diffusion.

A small chamber may be provided at the outlet of the cyclone comparable in volume to the cyclone itself to act as a diffuser. Similarly, a spacer may be provided at the outlet of the cyclone to act as a diffuser.

A plurality of cyclones may be provided such that their outlet flows coincide and interfere with each other to create extra shear forces.

The airflow to the drug dosing device may be provided by an external air source, for example a source of compressed air. In a preferred arrangement, however, the airflow is provided by a pump in the inhaler. Thus, the inhaler may comprise a pump. The pump may be in the form of, for example, a piston pump, a resilient bladder or a source of compressed gas, such as a gas canister. Preferably, the pump is arranged to provide an airflow of repeatable volume and velocity. Thus, the pump may take the form of a spring-powered piston received in a cylinder.

It has been identified that a problem associated with inhalers of the type according to the invention is that when the aerosol is expelled into the chamber, the aerosol tends to interact unfavorably with the air in the chamber. It is known for the chamber to be open and for the air initially within the chamber to be expelled through the mouthpiece of the chamber as the aerosol is introduced through a nozzle. However, this has been found to be unsatisfactory as the amount of medicament which escapes through the mouthpiece before the user inhales is unquantifiable.

Thus, viewed from a further aspect, the invention provides an inhaler comprising:

a chamber having a mouthpiece; and

an aerosolizing device having an inlet for taking in an airflow and an outlet for expelling an aerosol into the chamber, wherein the inlet of the aerosolizing device is connected to the chamber, such that, in use, the airflow is drawn from the chamber to generate the aerosol.

Thus, according to this aspect of the invention air from within the chamber passes through the aerosolizing device to generate the aerosol so that the chamber can be filled with aerosol without expelling air, and potentially medicament, through the mouthpiece of the chamber.

The aerosolizing device may comprise a cyclone and/ or a drug dosing device as previously described. The aerosolizing device may also comprise a pump arranged to draw air from the chamber via the inlet.

In one arrangement, the chamber receives a plunger which is arranged to force air through the aerosolizing device as the plunger moves through the chamber. In a particularly preferred embodiment, the aerosolizing device is mounted on the plunger.

Thus viewed from a yet further aspect the invention provides an inhaler comprising a chamber having a mouthpiece and a plunger received in the chamber, wherein the plunger is arranged to force air through an aerosolizing device to generate an aerosol of medicament in the chamber for inhalation through the mouthpiece.

BRIEF DESCRIPTION OF THE DRAWIINGS

Some embodiments of the invention will now be described by way of example only and with reference to the accompanying drawings, in which:

Figure 1 shows a cyclone for use in the invention;

Figure 2 shows a first embodiment of the invention;

Figure 3 shows a second embodiment of the invention;

Figure 4 shows a third embodiment of the invention;

Figure 5 shows a fourth embodiment of the invention; and

Figure 6 shows a fifth embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Corresponding reference numerals have been used for corresponding parts in each embodiment of the invention.

Figure 1 shows a cyclone 1 for use in aerosolizing a powdered medicament according to the invention. The cyclone 1 is in the form of a cylinder 3 of a diameter between about 2 and 15 mm, preferably between 4 and 10 mm. The cylinder 3 is closed at an input end and provided with a frustoconical portion 5 at an output end. The cyclone 1 has an inlet 9 in the region of the closed input end of the cylinder 3, which input 9 is substantially tangential to the wall of the cylinder 3. The frustoconical portion 5 has an outlet 7 defined therein, which outlet 7 is concentric with the axis of the cylinder 3.

In use, an airflow entrains a powdered medicament and enters the cyclone 1 through the tangential inlet 9, as indicated by arrows A. The airflow (and medicament) is directed by the internal surface of the cylinder 3 in a helical path towards the outlet 7. The frustoconical portion 5 of the cyclone 1 narrows the radius of the helical path, thereby increasing the speed of the airflow and increasing the shear forces on the entrained medicament. Consequently, an aerosol of powdered medicament having particles of respirable size issues from the outlet 7 of the cyclone 1, as indicated by arrows B.

Figure 2 shows a first embodiment of the invention. According to this embodiment a cyclone 1 is connected to a chamber 11 having a mouthpiece 13. The chamber has a volume of around 300 ml. The cyclone 1 is located at an end of the chamber 11 opposite the mouthpiece 13, and the outlet 7 of the cyclone 1 is arranged to eject the aerosol of medicament into the chamber 11 towards the mouthpiece 13, as indicated by arrows B.

A drug dosing device 15 is connected to the inlet 9 of the cyclone 1 and is arranged such that, as a flow of air passes through the dosing device 15, a controlled dose of medicament is entrained in the airflow.

The airflow to the drug dosing device 15 is provided by a pump 17, which comprises a plunger 19 received in a pump cylinder 21 and biased towards an outlet 23 of the pump 17 by a spring 25. A breath- actuated mechanism (not shown) is used to retain the plunger 19 in a retracted position

against the biasing force of the spring 25 until the medicament is to be delivered.

In use, this embodiment of the invention operates as follows. The user primes the inhaler by pulling the plunger 19 of the pump 17 into the retracted position where it is retained by the breath-actuated mechanism. The user then inhales through the mouthpiece 13 of the chamber 11 and the resultant drop in pressure causes the breath-actuated mechanism to release the plunger 19 which forces a jet of air through the outlet 23 and the drug dosing device 15. The flow of air entrains a measured dose of medicament from the dosing device 15 and carries this dose into the cyclone 1. In the cyclone 1, the dose of medicament is aerosolized, as described in relation to Figure 1, and is expelled into the chamber 11 through the outlet 7, as indicated by the arrows B. The user is then able to inhale the aerosol of medicament into the deep lung via the mouthpiece 13.

Figure 3 shows a second embodiment of the invention. In this embodiment, the arrangement of the pump 17, dosing device 15 and cyclone 1 corresponds substantially to that of the embodiment of Figure 2. However, in this case the chamber 11 is larger than that shown in Figure 2 and the mouthpiece 13 is offset from the axis of the chamber 11 and of the cyclone 1. The mouthpiece 13 is provided with a cap 27 which closes off the mouthpiece, sealing the chamber 11 from the atmosphere. The cap 27 also closes off an air intake passage 29 which is provided in the chamber 11 to allow air to enter the chamber 11 when the user inhales through the mouthpiece 13. The chamber 11 connects to the outlet 23 of the pump 17 via an air passage 31 and a first non-return valve 33. A second non-return valve 35 is provided between the outlet 23 of the pump 17 and the drug dosing device 15.

In operation of this embodiment, the plunger 19 of the pump 17 is withdrawn (as in the embodiment of Figure 2) which causes air to be drawn out of the chamber 11 through the air passage 31 and into the pump cylinder 21 via the first non-return valve 33. In this manner, the pressure in the chamber 11 is reduced to below atmospheric. It is to be noted that the release of the plunger 19 in this embodiment is not effected by a breath-actuated device but by a manually actuated release mechanism (not shown). When the release mechanism is actuated, the plunger 19 forces a jet of air

through the second non-return valve 35 into the drug dosing device 15 where a measured dose of the medicament is entrained in the air stream. The airflow and entrained medicament pass into the cyclone 1 where the medicament is aerosolized and expelled from the outlet 7 of the cyclone 1 into the chamber 11, as indicated by the arrows B. The reduced pressure in the chamber 11 at this point ensures an even distribution of the aerosol within the chamber 11. The pressure is equalized by the ejection of the aerosol into the chamber 11. Once the aerosol has been delivered into the chamber 11, the user removes the cap 27 and inhales the aerosol through the mouthpiece 13.

Figure 4 shows a third embodiment of the invention. According to this embodiment, there is no pump 17, but a plunger 19 is provided within the chamber 11 so that the chamber itself acts as a pump cylinder. Thus, as the plunger 19 is driven in the direction of the arrow C, air is forced out of the chamber 11 through the air passage 31 and into the drug dosing device 15. As the air passes through the drug dosing device 15 it entrains a measured dose of medicament which passes into the cyclone 1 and is aerosolized and expelled into the chamber 11, as indicated by the arrows B. The user inhales the aerosol of medicament by removing the cap 27 and inhaling through the mouthpiece 13.

Figure 5 shows a fourth embodiment of the invention according to which the cyclone 1, the drug dosing device 15 and the air passage 31 are mounted on the plunger 19 and are movable therewith such that when the plunger 19 is moved in the direction of the arrow C, air from the lower half of the chamber 11 passes into the air passage 31 and through the drug dosing device 15, so that an aerosol of medicament is expelled from the cyclone 1 into the upper half of the chamber 11, in the direction of the arrows B.

Figure 6 shows a fifth embodiment of the invention which corresponds substantially to that of Figure 4 except that the cyclone 1 in this embodiment is located in a lower region of the chamber 11 and the direction of movement of the plunger 19 to generate the aerosol is reversed, as indicated by arrow C.

The embodiments of Figures 3 to 6 each have the particular advantage that the airflow which is used to entrain the medicament and generate the aerosol via the cyclone 1 is drawn from the chamber 11. Thus, a substantially equal volume of air is withdrawn from the chamber 11 to generate the aerosol

as is returned to the chamber 11 when the aerosol is expelled from the cyclone 1. In this way, there is no requirement for the chamber 11 to be vented to atmosphere while the aerosol is generated and there is therefore no risk that any of the medicament will be lost before inhalation by the user.

Although there have been described herein a number of discrete embodiments, the features described in relation to any particular embodiment may be used in combination with the features of other embodiments described herein.

Although the aerosol of medicament has been described herein as an aerosol of powdered medicament in air, the medicament may be dispersed in any other gas or mixture of gases, as required.

What is Claimed:

1. An inhaler comprising:

a chamber having a mouthpiece;

a cyclone arranged to eject an aerosol of medicament into the chamber; and

a drug dosing device arranged to provide a dose of powdered medicament to the cyclone.

2. An inhaler as claimed in claim 1, wherein the drug dosing device is arranged to provide a dose of powdered medicament entrained in an airflow to the cyclone.

3. An inhaler as claimed in claim 1, wherein the cyclone is in the form of a cylinder of a diameter between about 2 and 15 mm.

4. An inhaler as claimed in claim 3, wherein the diameter of the cylinder is between 4 and 10 mm.

5. An inhaler as claimed in claim 1, wherein the chamber is comparable in volume to the cyclone.

6. An inhaler as claimed in claim 1, wherein the chamber has a volume of around 300 ml.

7. An inhaler comprising:

a chamber having a mouthpiece; and

an aerosolizing device having an inlet for taking in an airflow and an outlet for expelling an aerosol into the chamber,

wherein the inlet of the aerosolizing device is connected to the chamber, such that, in use, the airflow is drawn from the chamber to generate the aerosol.

8. An inhaler as claimed in claim 7, wherein the chamber receives a

plunger which is arranged to force air through the aerosolizing device as the plunger moves through the chamber.

9. An inhaler as claimed in claim 8, wherein the aerosolizing device is mounted on the plunger.

10. An inhaler comprising a chamber having a mouthpiece and a plunger received in the chamber, wherein the plunger is arranged to force air through an aerosolizing device to generate an aerosol of medicament in the chamber for inhalation through the mouthpiece.

11. An inhaler as claimed in claim 2, wherein the cyclone is in the form of a cylinder of a diameter between about 2 and 15 mm.

12. An inhaler as claimed in claim 2, wherein the chamber is comparable in volume to the cyclone.

13. An inhaler as claimed in claim 3, wherein the chamber is comparable in volume to the cyclone.

14. An inhaler as claimed in claim 4, wherein the chamber is comparable in volume to the cyclone.

15. An inhaler as claimed in claim 2, wherein the chamber has a volume of around 300 ml.

16. An inhaler as claimed in claim 3, wherein the chamber has a volume of around 300 ml.

17. An inhaler as claimed in claim 4, wherein the chamber has a volume of around 300 ml.

18. An inhaler as claimed in claim 5, wherein the chamber has a volume of around 300 ml.

19. An inhaler as claimed in claim 11, wherein the chamber has a volume of around 300 ml.

20. An inhaler as claimed in claim 12, wherein the chamber has a volume of around 300 ml.

Amended claim

1. An inhaler comprising:

a chamber (11) having a mouthpiece (13);

a cyclone (1) configured as a substantially cylindrical cavity (3) provided with a tangential inlet (9) and an axial outlet (7) arranged to eject an aerosol of medicament into the chamber (11);

a drug dosing device (15) arranged to provide a dose of powdered medicament entrained in an airflow to the cyclone (1); and

a pump (17) for providing the air flow to the drug dosing device (15),

characterized in that

the diameter of the cylindrical cavity is between 4 and 10 mm, and

the pump (17) is a piston pump comprising a spring-powered piston (19, 25) received in a pump cylinder (21).

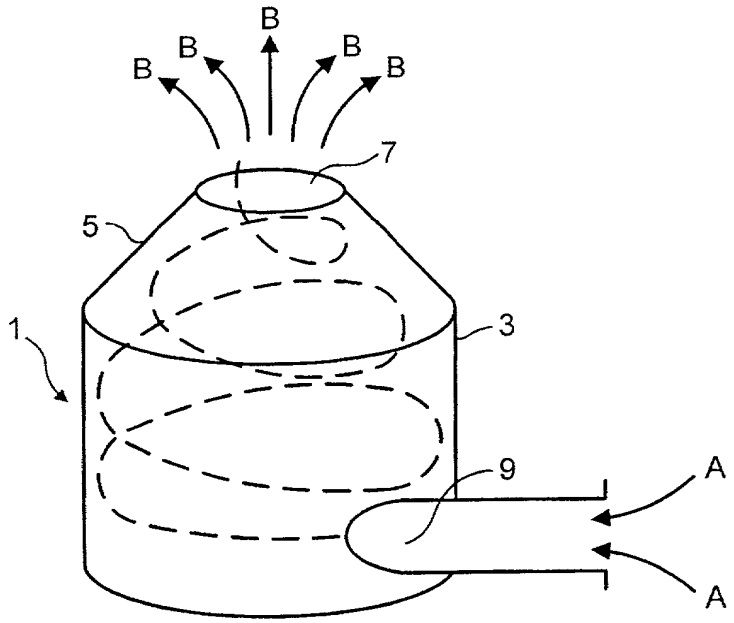

FIG. 1

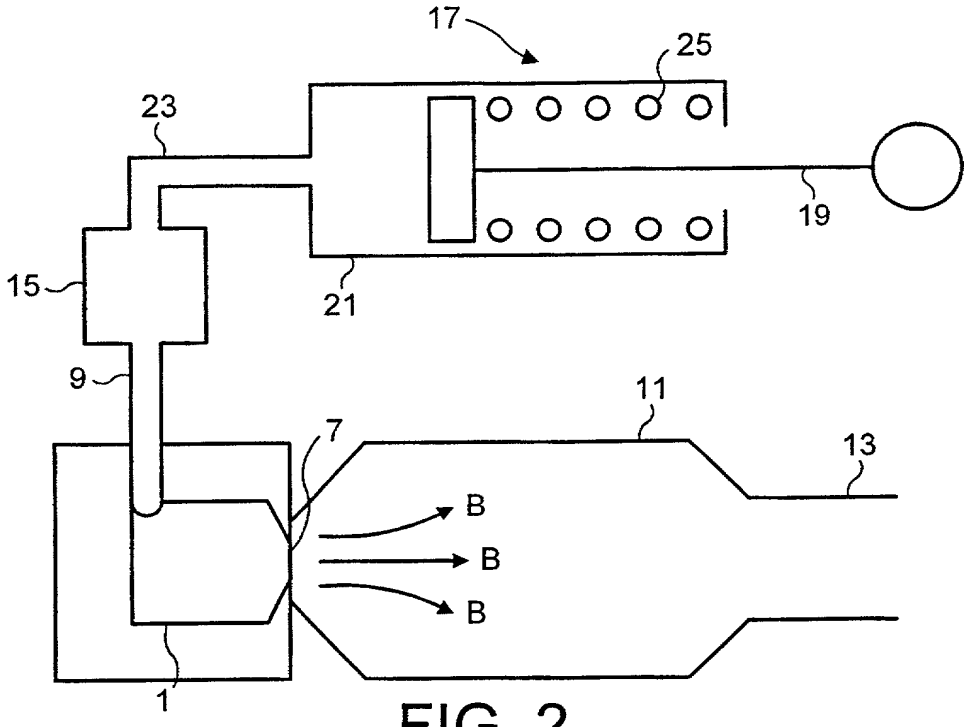

FIG. 2

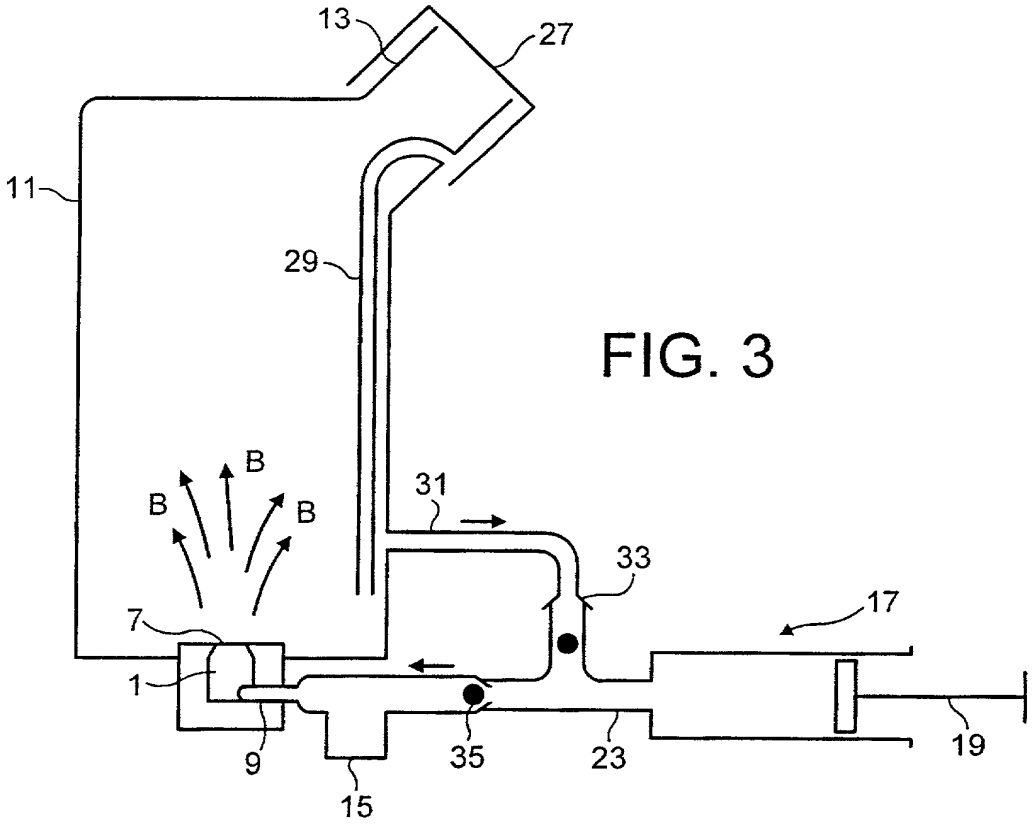

FIG. 3

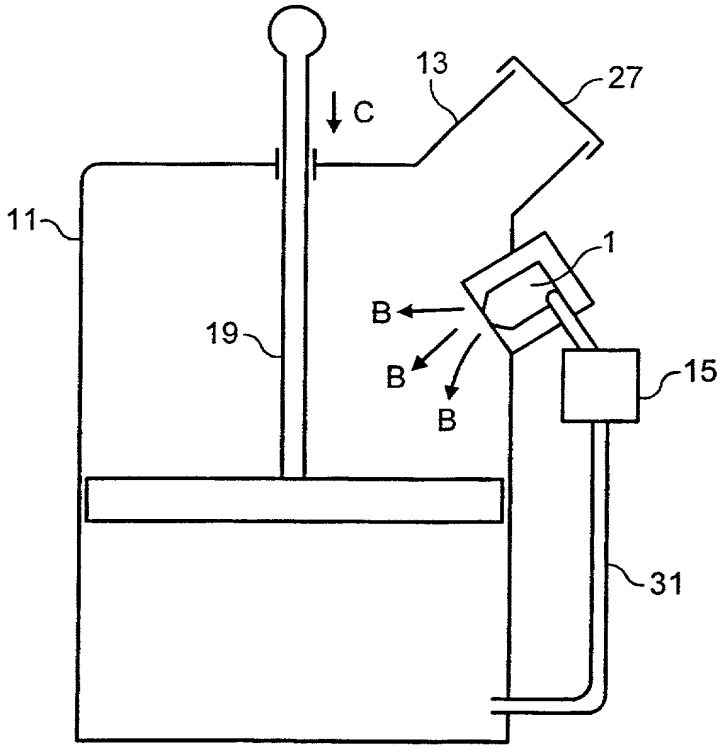

FIG. 4

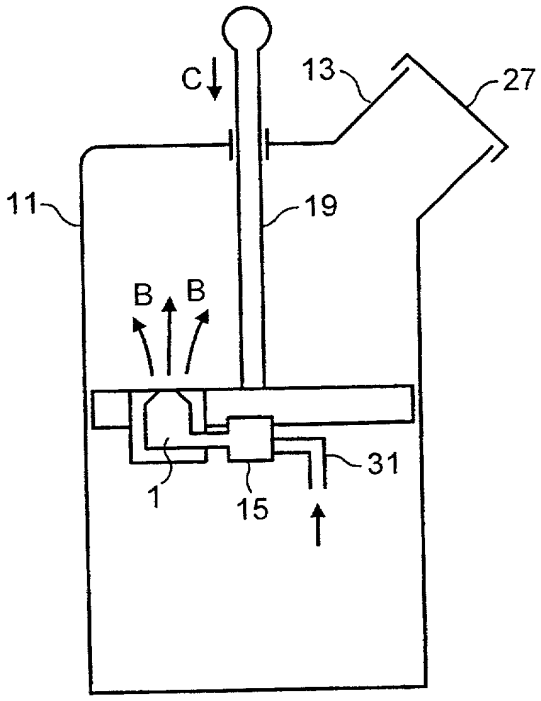

FIG. 5

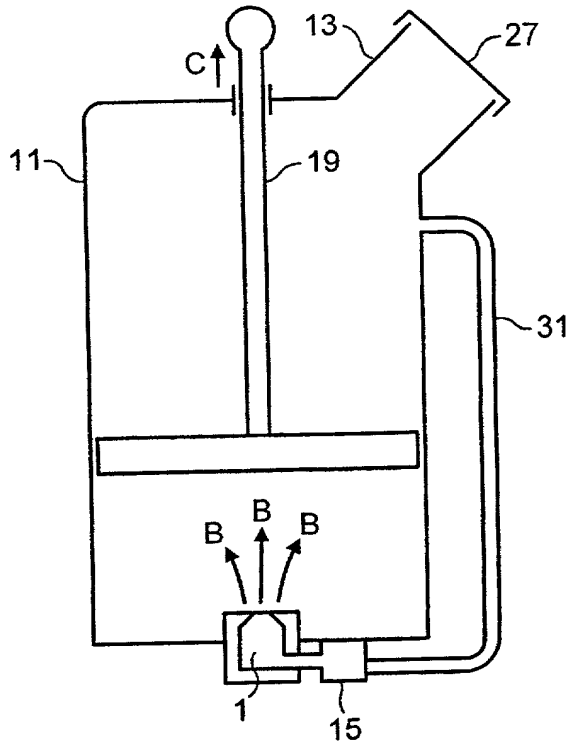

FIG. 6

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DECLARATION

☒ Declaration Submitted with Initial Filing ☐ Declaration Submitted after Initial Filing

Attorney Docket	DHN/321/PC/US
First Named Inventor	Quentin J. Harmer, et al
COMPLETE IF KNOWN	
Application Number	
Filing Date	
Group Art Unit	
Examiner Name	

As an above named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

Inhalers

(Title of the Invention)

the specification of which

☐ is attached hereto

OR

☒ was filed on (MM/DD/YYYY) June 23, 2000 as United States Application or PCT International Application Number PCT/EP00/06831, and was amended on (MM/DD/YYYY) _____ (if applicable).

I hereby state that I have reviewed and understood the contents of the above-identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37 Codes of Federal Regulations, §1.56.

I hereby claim foreign priority under Title 35, United States Code § 119 (a)-(d) or § 365 (b) of any foreign application(s) for patent or inventor's certificate, or § 365 (a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Numbers	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Copy Attached Yes	Copy Attached No
9914722.5	United Kingdom	June 23, 1999	☐	☐	☐
			☐	☐	☐
			☐	☐	☐
			☐	☐	☐

☐ Additional foreign application numbers are listed on a supplemental priority sheet attached hereto:

I hereby claim the benefit under Title 35, United States Code § 119 (e) of any United States provisional application(s) listed below:

Application Number(s)	Filing Date (MM/DD/YY)	
		☐ Additional provisional application numbers are listed on a supplemental priority sheet attached hereto.

DECLARATION	Page 2

I hereby claim the benefit under Title 35, United States Code §120 of any United States application(s), or §365(c) of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT international application in the manner provided by the first paragraph of Title 35, United States Code §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Title Code of Federal Regulations §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

U.S. Parent Application Number	PCT Parent Number	Parent Filing Date (MM/DD/YYYY)	Parent Patent Number (if applicable)

☐ Additional U.S. or PCT international application numbers are listed on a supplementary priority sheet attached hereto:

As a named inventor, I hereby appoint the registered practitioners associated with the Customer Number provided below to prosecute this application and to transact all business in the Patent and Trademark Office therewith, and direct that all correspondence be addressed to that Customer Number:

Firm Name: Alix, Yale & Ristas, LLP Customer Number: 002543

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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Applicant Authority							

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Applicant Authority							

☒ Additional inventors are being named on supplemental sheet(s) attached hereto.

Type a plus sign (+) inside this box → [+]

DECLARATION	ADDITIONAL INVENTOR(S) Supplemental Sheet

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Applicant Authority							

Name of Additional Joint Inventor, if any: ☐ A petition has been filed for this unsigned inventor

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Inventor's Signature				Date			
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City		State		Zip		Country	
Applicant Authority							

Name of Additional Joint Inventor, if any: ☐ A petition has been filed for this unsigned inventor

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Inventor's Signature				Date			
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City		State		Zip		Country	
Applicant Authority							

Name of Additional Joint Inventor, if any: ☐ A petition has been filed for this unsigned inventor

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Inventor's Signature				Date			
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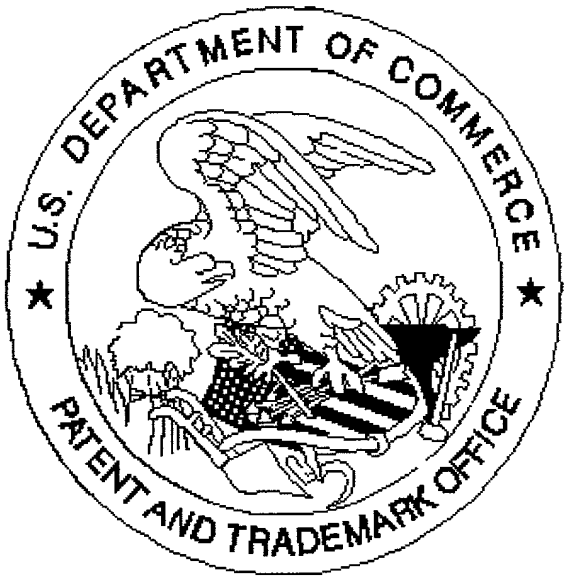

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